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Quarterly Technical Summary

Educational Technology Program

15 June 1975

Prepared for the Department of the Air Force
under Electronic Systems Division Contract F19628-73-C-0002 by

Lincoln Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LEXINGTON, MASSACHUSETTS

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Eugene C. Raabe, Lt. Col., USAF
Chief, ESD Lincoln Laboratory Project Office

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

EDUCATIONAL TECHNOLOGY PROGRAM

QUARTERLY TECHNICAL SUMMARY REPORT TO THE AIR FORCE SYSTEMS COMMAND

1 MARCH – 31 MAY 1975

ISSUED 15 JULY 1975

LEXINGTON MASSACHUSETTS

ABSTRACT

Field tests of the stand-alone system (LTS-3S) were successfully carried out for the U. S. Bureau of Mines. Performance tests of the improved audio reader suggest that the present reader design will meet the requirements for the LTS-5 prototype.

Work has been initiated on the development of a student data-recording system.

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EDUCATIONAL TECHNOLOGY PROGRAM

I. INTRODUCTION

Two milestones in the LTS development program were passed during this quarter.

(a) The first formal field test of the stand-alone system (LTS-3S) was carried out under auspices of the U. S. Bureau of Mines. Two terminals were transported to the two sites involved and placed in immediate operation. Student reaction and training results were consistent with the findings of the very successful Air Force test of the LTS-3 system at Keesler Air Force Base.

(b) Performance tests of the Rohlix-based audio reader conducted this quarter have yielded very satisfactory results. It appears that the present reader design will meet LTS-5 requirements.

II. LTS COURSEWARE DEVELOPMENT

A brief study has been carried out on the training of coal mine technicians on LTS under auspicies of the U. S. Bureau of Mines. Twenty-five trainees were given one hour of instruction each on materials prepared for this study. The conditions were different in almost all respects from the prior, extensive test in electronic training at the Keesler Air Force Base School for Applied Aerospace Sciences. Here the materials (a) impart basic knowledge about the effects of electricity on the human body and (b) instruct in how federal regulations govern safe electrical hookup of mine equipment; in the previous case, principles of electricity and electronic bench exercises were the subject matter. In this new study, students were drawn from a civil vocational school at the high-school level and from among miners with several years experience in the industry. Instruction was carried on in both a vocational school and in an industrial maintenance training shop. No equipment installation was involved: two LTS-3S terminals were transported to the site, unloaded, and placed in operation by simply plugging them into the nearest outlet. Despite the major differences, the new results were consistent with all the findings of the previous Air Force Study (Keesler Project Report 72-112). Substantial learning occurred, as indicated by a comparison of pre- and post-test scores. An attitude survey and informal remarks showed strong acceptance of this form of training by all the students. As in the prior study, these lesson materials were previously untested in the training environment; yet, students learned rapidly from the machine with virtually no outside help.

III. MAINTENANCE MANAGEMENT SYSTEM

An LTS-3S has been delivered to Robins Air Force Base and has been in use for several weeks. All the procedures for performance measurement and alignment of the AN/TRC-97A have been committed to fiche and checked out at Robins by maintenance experts. In addition, six modules of Career Development Course (CDC) material, prepared for the LTS-3S by personnel from the Technical Training Center at Keesler Air Force Base, have been committed to fiche. The modules, consisting of fourteen fiche, represent about 5 or 6 hours of CDC material. Topics covered include tropospheric scatter, tunnel diodes, AN/TRC-97A receivers, threshold extenders, and baseband combiners.

Originally, the Air Force Communications Service (AFCS) project plan predicted that data collection on the LTS-3S at Robins would begin on 1 April. However, field operations of the 5th Mobile Communications Group (MCG) required that all AN/TRC-97As be committed for operation Solid Shield and consequently the LTS could not be used as planned. It is now estimated that formal data collection will begin on 15 June.

Some of the 5th MCG personnel have studied the CDC material and the performance procedures. Several new personnel, inexperienced in TRC-97A maintenance, are arriving at Robins and also will use the LTS to study the CDC material and maintenance procedures. The 5th MCG NCO, trained by Lincoln to maintain the LTS, is being reassigned and is currently training another NCO as his replacement.

IV. LTS HARDWARE DEVELOPMENT

The Rohlix-based reader has been successfully cycle tested under normal terminal operating conditions. The reader exhibits a gain range of more than 17 dB and is able to accommodate frame positioning errors which are equivalent to 3-percent FM.

Several recording systems have been investigated for use as a student data-recording facility. An initial system has been configured using a floppy disk as the recording medium and will be used to support a Digital Systems Engineering Course which will be offered on the LTS. A system employing digital tape cassettes also will be implemented to permit comparisons of reliability, cost, and ease of data handling.

A. Reader Development

The Rohlix-based reader was mounted on a converted bell housing and installed in an LTS-3S terminal. Initially, the FM introduced by eccentricities in the motor pulley, which drives the reader turntable belt, was found to be excessive. The FM was reduced to an acceptable level by fabricating a more concentric pulley which is attached to the shaft by a collet and mounted such that the working portion of the pulley is located over the motor shaft rather than cantilevered beyond it.

The reader was tested under terminal operating conditions to determine the allowable range of loop gain and the maximum value of frame positioning error which could be accommodated. A block diagram of the reader servo system is shown in Fig. 1. Acquisition and tracking tests

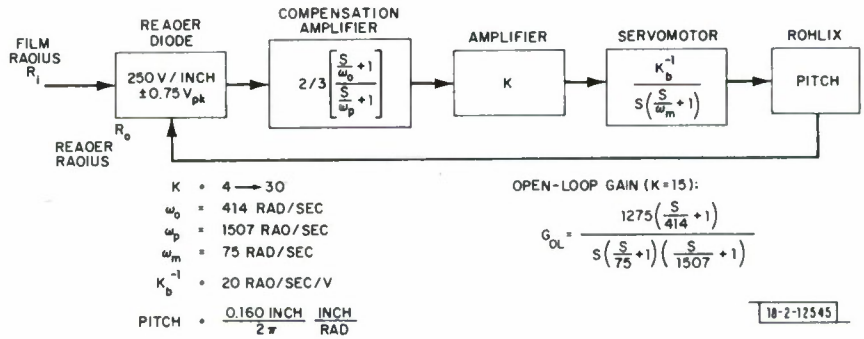

Fig. 1. Reader servo system.

were performed for frame positioning offsets, with respect to the reader, in four quadrants. A test was considered successful for the case where a spiral was acquired and tracked and the corresponding data was decoded by the terminal self-processor. The results of the tests indicated that the system is capable of accommodating positional offsets corresponding to 3-percent FM. The format of the present spiral is such that in one quadrant the maximum FM which can be accommodated is 2.2 percent. For this case, the reader acquires the track in the middle of the data preamble and word framing is lost.

The results of the gain range tests are shown in Fig.2. The nominal operating point is described in terms of the amplifier gain (K) and is chosen to allow approximately a 6-dB increase and a 12-dB decrease in gain for variations in film processing, light level, and mechanical degradation. As a point of reference, it should be noted that corresponding tests on the LTS-3S tracker indicate a total gain range of approximately 10 dB.

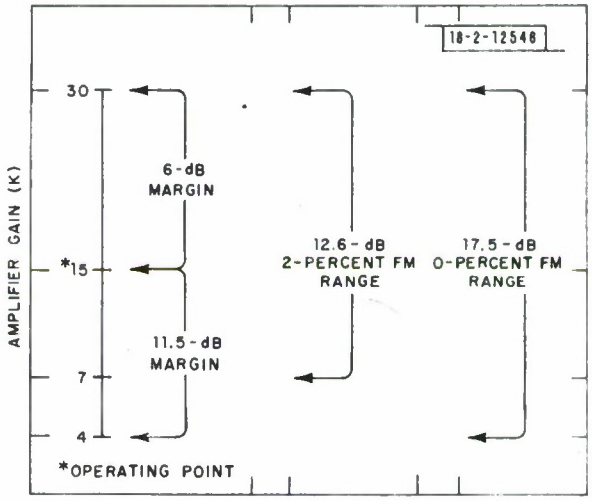

Fig. 2. Reader servo-system gain range.

In conjunction with the system tests, mechanical life tests are being conducted on the Rohlix mounted in a fixture which simulates the reader motion. Test results indicate that after more than 10^6 equivalent access cycles, the Rohlix does not show appreciable wear; however, the shaft which drives the Rohlix did indicate wear after 60,000 cycles. Future tests will be attempted with a case-hardened shaft.

The reader is presently undergoing cycle tests and has acquired and tracked approximately 2000 frames of data and audio under normal terminal operating conditions without failure. Alternate motor and Rohlix combinations will be tested to determine the optimum configuration in terms of reliability and performance.

B. Student Data Recording

The collection of student data is necessary to facilitate student management, record keeping, and certification. Currently, student response is printed on a teletype and, if desired, punched on paper tape. This medium, in addition to being slow, is not economical. Therefore, efforts have been initiated to develop a silent self-contained recording system which can be optimally connected to each stand-alone terminal.

The total data to be collected from a student terminal for a 40-hour week is estimated to be 50K bytes. Two recording systems which appear feasible for this application are flexible (floppy) disks and magnetic tape cassettes. A standard floppy disk has a maximum capacity of 256K bytes but requires that an entire sector be written at once. The smallest sector size is 128 bytes; therefore, a limited amount of buffer storage is required to fully utilize the disk. Since the data transfer rate is 250 kbps, the total contents of the disk can be transferred to a computer for analysis in 8 sec.

Digital cassettes have a maximum storage capacity of 300K bytes (300-foot tape) but usable capacity depends upon the length of each record. For a buffer storage capacity of 128 bytes, the usable capacity is about 215K bytes. The maximum transfer rate for the cassette tape varies from 2.4 to 24 kbps, depending upon the particular drive mechanism. For these rates, the corresponding cassette to computer transfer times are 17 and 1.7 minutes. The characteristics of the media are summarized in Table I.

TABLE I
COMPARISON OF RECORDING SYSTEMS

	Floppy Disk	Digital Cassette
Maximum capacity	256K bytes	300K bytes
Usable capacity		
With 128-byte buffer	256K bytes	215K bytes
Without 128-byte buffer	20K bytes	42K bytes
Data transfer rate	256K bytes/sec	2.4 to 24 kbps
Minimum time to read entire file	8 sec	17 to 1.7 minutes

Initial development efforts have been concentrated on interfacing one of the author support facility floppy-disk systems to an LTS terminal. A programmable interface employing an Intel 8080 microprocessor has been designed and fabricated and is presently being checked out. The microprocessor capability matches the high-speed data transfer and buffer requirements of the disk and, in addition, offers flexibility in data formatting.

The 8080 disk interface will be combined with the second-generation terminal self-processor (Intel 4040), described in the previous Quarterly Technical Summary,* to support the National Science Foundation (NSF) sponsored course on Digital Systems Engineering which will be offered on the LTS. The block diagram for this configuration is shown in Fig. 3.

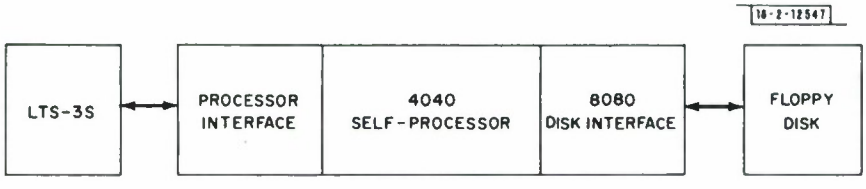

Fig. 3. Block diagram of student data-recording facility.

Since the cassette tape system appears to be a more economical approach for data recording, future efforts will be directed at the selection and interfacing of an appropriate cassette recording system. An advantage of the cassette tape system is the fact that a high-speed terminal interface is not required.

* Educational Technology Program Quarterly Technical Summary, Lincoln Laboratory, M.I.T. (15 March 1975), p. 3, DDC AD-A008502.

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Field tests of the stand-alone system (LTS-3S) were successfully carried out for the U.S. Bureau of Mines. Performance tests of the improved audio reader suggest that the present reader design will meet the requirements for the LTS-5 prototype.

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